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1 to a die in step-by-step movement that is mechanically synchronized with  
2 the stroke of the punch. The treadle also includes opposed pairs of  
3 vertical guide strips between each article. Each guide strip is carried by  
4 a spacer that is mounted onto a cross frame member of the treadle.  
5 Opposed pairs of guide strips, provided between each adjacent pair of  
6 formed articles in the sheet, are spaced apart slightly from each other  
7 by a distance slightly greater than the thickness of the sheet passing  
8 therebetween. However, such close spacing coupled with the use of  
9 guide strips between every adjacent pair of articles results in increased  
10 frictional forces which tends to result in mis-feeding and jamming of the  
11 treadle, particularly when running the treadle at relatively high product  
12 feed rates.

#### 13 14 SUMMARY OF THE INVENTION

15 *B.* A treadle device is provided for conveying, guiding, and locating  
16 web-supported articles or products during a web processing operation.  
17 More particularly, a treadle assembly guides web-supported articles into  
18 a trim press prior to and while severing the articles from the web.  
19 Such treadle device provides accurate location of articles while moving  
20 the web while and reducing frictional forces generated between the  
21 treadle and web which otherwise result in an increased occurrence of  
22 mis-feeds and misalignment of the web and articles, particularly during  
23 relatively high speed trim operations. An additional degree of accuracy

1 is also provided during such severing operation over that previously  
2 provided via use of accurate high speed conveying, guiding, and locating  
3 techniques. Additionally, feedback controlled operation is maintained to  
4 drive a servo pick and servo helper of a web feed delivery device  
5 associated with the treadle and trim press.

6 According to one aspect, a trim press article handling apparatus  
7 includes a frame, a punch, a die, and a treadle. The punch is carried  
8 by the frame. The die is carried by the frame and cooperates in relative  
9 movement with the punch to sever articles from a web. The treadle is  
10 carried for movement relative to the die. The treadle includes a web  
11 guide member, a primary guide strip spaced from the guide member  
12 slightly greater than a thickness of the web, a secondary guide strip  
13 spaced from the guide member at least four thicknesses of the web and  
14 spaced apart from the primary guide strip, and an article detector carried  
15 by at least one of the primary guide strip and the secondary guide strip.  
16 The article detector is operative to detect position of an article in the  
17 web by detecting the position of a protuberance in the web as the  
18 protuberance is conveyed between the primary guide strip and the  
19 secondary guide strip.

20 According to another aspect, an article conveying, guiding, and  
21 locating device includes a treadle, a web conveyor, an article detector,  
22 and a controller. The treadle includes a web guide plate, and a guide  
23 strip spaced slightly greater than a thickness of the web from the guide

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1 plate. The web conveyor has a servo pick assembly and a servo helper  
2 assembly driven by a servo motor, and is configured to move a web of  
3 articles wherein the servo pick assembly is carried by the treadle. The  
4 article detector is carried by the treadle and is operative to detect  
5 location of an article in the web during movement of the web. The  
6 controller communicates with the drive motors and the article detector  
7 and is operative to controllably regulate and synchronize operation of the  
8 servo pick assembly and the servo helper assembly in response to  
9 detected location of the article.

10 According to yet another aspect, a method is provided for  
11 delivering web-supported articles between dies and punches of a trim  
12 press, including: providing a treadle having an article detector; while  
13 moving the web and articles, guiding the web and articles along the web  
14 and between a pair of articles in a row extending transverse to a travel  
15 path direction; detecting location of an article in the web using the  
16 article detector; in response to detecting the location of the article,  
17 controllably moving the web to position the article between a  
18 corresponding punch and die of the trim press.

## 19 20 **BRIEF DESCRIPTION OF THE DRAWINGS**

21 Preferred embodiments of the invention are described below with  
22 reference to the following accompanying drawings.  
23

1 Fig. 1 is a vertical side view of a thermoforming machine trim  
2 press having a treadle conveying, guiding, and locating device embodying  
3 one aspect of the invention.

4 Fig. 2 is a simplified partial perspective view of the treadle of  
5 Fig. 1 and illustrates an article sensing device provided by the treadle.

6 Fig. 3 is a simplified sectional view taken generally along line 3-3  
7 of Fig. 2 but including the trim press punch plate and die plate of  
8 Fig. 1 and further showing the control system and servo pick conveyor.

9 Fig. 4 is an enlarged, simplified sectional view of the primary  
10 guide member and web guide plate taken generally along line 3-3 of  
11 Fig. 2 and including a web containing articles.

12  
13 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

14 This disclosure of the invention is submitted in furtherance of the  
15 constitutional purposes of the U.S. Patent Laws "to promote the progress  
16 of science and useful arts" (Article 1, Section 8).

17 Reference will now be made to a preferred embodiment of  
18 Applicant's invention. One exemplary implementation is described below  
19 and depicted with reference to the drawings comprising an article  
20 conveying, guiding, and locating device and method for aligning articles  
21 within a web of thermoformable material for a severing operation.  
22 While the invention is described by way of a preferred embodiment, it  
23 is understood that the description is not intended to limit the invention

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1 to this embodiment, but is intended to cover alternatives, equivalents,  
2 and modifications such as are included within the scope of the appended  
3 claims.

4 In an effort to prevent obscuring the invention at hand, only  
5 details germane to implementing the invention will be described in great  
6 detail, with presently understood peripheral details being incorporated by  
7 reference, as needed, as being presently understood in the art.

8 A preferred embodiment of Applicant's invention is shown on a  
9 thermoforming machine trim press having a treadle system that is  
10 generally designated with reference numeral 10 in Figure 1. More  
11 particularly, treadle system 10 is provided on a trim press 12 to  
12 accurately convey, guide, and locate articles 14 formed within a sheet,  
13 or web, 16 of thermoformable material during an article trim operation  
14 that severs articles 14 from web 16. Treadle system 10 is operative to  
15 intermittently convey and align articles 14 so as to successively sever  
16 rows of such articles 14 from the web 16.

17 A control system 18 of treadle system 10 choreographs operation  
18 of trim press 10 acting in unison with a servo motor driven conveyor 20  
19 that includes a servo pick assembly 60 and a servo helper assembly 62.  
20 Conveyor 20 moves web 16 in which individual articles, or products, 14  
21 have previously been formed using a thermoforming machine (not shown).  
22 In operation, web 14 is driven in intermittent motion using control  
23 system 18 and conveyor 20 to successively feed individual rows of articles

14 into trim press 12 where the articles 14 are severed from web 16. During closure of trim press 12, treadle 10 aids in accurately positioning articles 14 with respect to punch and die members 22 and 24 just prior to severing articles 14 from web 16.

Further details of one exemplary trim press similar to trim press 12, but configured in a vertical orientation are disclosed in Applicant's co-pending U.S. Patent Application Serial No. 09/576,219, entitled "Article Stacking Device, Trim Press Article Accumulator, and Method of Stacking Thermoformed Articles", naming Jere F. Irwin as inventor. Such U.S. Patent Application Serial No. 09/576,219 is herein incorporated by reference. Trim press 12, as depicted herein, is a modified version of Applicant's commercially available trim press "Model 28NT Trim Press", sold by Irwin Research and Development, of Yakima, Washington. The modifications entail adding the novel control system 18, conveyor assembly 20, and treadle system 10.

In order to improve the speed and accuracy with which articles 14 are severed from web 16 by trim press 12, treadle 10 is provided on trim press 12 incorporating desired features of Applicant's invention. Treadle 10 provides highly accurate article conveying, guiding, and locating when delivering web-supported articles between punches 22 and dies 24 of trim press 12.

Trim press 12 includes a movable platen 26, a stationary platen 28, a punch plate 30, and a die plate 32. Punch plate 30 is carried for



four guide posts can be configured to support platen 26 with two corresponding bronze bushings. The use of platen guide posts is understood in the art. Accordingly, such guide posts have been omitted from the figures in order to simplify the drawing and to prevent obscuring the invention at hand.

Additionally, a pair of stationary, cylindrical guide posts 44, 46 are rigidly supported by frame 42 to guide horizontal, reciprocating movement of treadle 10 relative to frame 42 and stationary platen 28. Bronze bushings 48 and 50-51 on treadle 10 are affixed to a frame 52 of treadle 10, and are configured to slide along guide posts 44, 46, respectively.

Stationary guide members 54 and 56, in the form of pairs of edge guide tracks and central guide tracks, form a self-feeding canopy 49 that guides web 16 and articles 14. More particularly, guide members 54 and 56 guide and move web 16 and articles 14 from a thermoforming machine (not shown), positioned upstream of trim press 12, downwardly into treadle 10 and between punch plate 30 and die plate 32 for severing articles 14 from web 16 therebetween.

Web conveyor assembly 20 moves web 16 and articles 14 along guide members 54 and 56 and through treadle 10. Web conveyor 20 comprises a servo pick assembly 60 and a servo helper assembly 62. Servo pick assembly 60 is carried by treadle 10, whereas servo helper assembly 62 is carried by guide member 54. Accordingly, servo pick

assembly 60 is carried for movement relative to stationary servo helper assembly 62.

As shown in Figure 1, web conveyor assembly 20 is illustrated in simplified form. More particularly, servo pick assembly 60 and servo helper assembly 62 are each depicted as a drive wheel assembly 64, 66, wherein each includes a servo motor (not shown) that is controllably actuated via a control system 18 to impart intermittent motion that feeds web 16 into trim press 12.

Servo pick assembly 60 and servo helper assembly 62, according to one construction, each include a Siemens servo motor Model Part No. 1FT5062-1AC71-4FA0, commercially available in the United States from Siemens Energy & Automation, of Atlanta, Georgia. Additionally, the servo motors for servo pick assembly 60 and servo helper assembly 62 each further includes a rotary encoder which is used in conjunction with the servo motor as a feedback signal to detect motion of drive wheels 72 and 78 in order to directly measure the amount of feed imparted by server helper assembly 62 relative to the feed of servo pick assembly 60. Accordingly, the servo helper assembly is synchronized in relation to the speed of the servo pick assembly.

According to prior art techniques, a servo pick assembly was utilized with a helper assembly having a variable speed motor. The variable speed motor was regulated so as to deliver a distance of web at least as much as that which is moved by the servo pick assembly.



approximately four-inch range, a different digital value is generated and delivered to control system 18. Accordingly, control system 18 monitors the proximity of web 16 relative to guide member 56 of canopy 49. When a significant amount of detected separation occurs between web 16 and guide member 56, control system 18 reduces the operating speed of drive wheels 78 for servo helper assembly 62. Accordingly, the delivery speed of servo helper assembly 62 relative to servo pick assembly 60 is controllably regulated by control system 18 in response to the signal detected by photo proximity switch 112. Alternatively, it is understood that any of a number of other proximity switches can be utilized, such as proximity mode ultrasonic sensors, or optical detectors.

By controllably regulating the operating speed of drive wheels 78 relative to drive wheels 72, the accumulation of web 16 therebetween is substantially prevented.

Accordingly, the need for a substantial accumulation area along guide member 54 is eliminated. Furthermore, motion of the web and articles is monitored at treadle 10 via article detector 80 and control system 18. For cases where servo helper assembly 62 does not exactly mimic the delivery rate for the servo pick assembly 60 or when misalignment is detected or likely to occur, control system 18 briefly and quickly opens or raises follower wheel 76 away from drive wheel 78 using a pneumatic cylinder which raises each follower wheel 76 along opposite edges of web 16. Hence, opening of follower wheels 76 for a





a common servo motor, a splined drive shaft, splined drive wheels, and a pair of correspondingly splined drive rollers attached to each drive wheel 78. Accordingly, actuation of drive wheel assembly 66 via controller 18 is operative to intermittently deliver rows of articles 14 into trim press 12 in cooperation with drive wheel assembly 64.

As shown in Figure 1, drive wheel assembly 64 comprises a dual servo motor driven roller feed assembly referred herein as servo pick assembly 60. According to one construction, follower wheels 70 and 76 are each formed from a high density polyethylene (HDPE) plastic material. Also according to one construction, drive wheels 72 and 78 are each formed from an anodized aluminum material having a knurled radial outer surface that coacts with web 16.

Additionally, web 16 is delivered through an oven and a thermoforming machine using a web conveyor, upstream of trim press 12. One exemplary detailed construction for a web conveyor is disclosed in U.S. Patent No. 5,806,745, herein incorporated by reference.

According to one construction, article registration is carried out by adjusting the operation of conveyor 20 using controller 18 in order to adjust the advancement and positioning of individual articles between punch plate 30 and die plate 32.

However, in some cases, it is very difficult to adjust the set-up and component positioning for a web conveyor in order to accurately and precisely deliver articles 14 between punch plate 30 and die plate 32.

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1 Hence, article registration implemented solely using conveyor set-up and  
2 control does not always sever such articles in a sufficiently uniform and  
3 accurate manner. Furthermore, there are limitations to the accuracy with  
4 which a servo motor can drive conveyor assembly 20, and therefore, in  
5 the ability of such servo motors to accurately place articles 14 between  
6 punch plate 30 and die plate 32. Oftentimes, it is the case that articles  
7 14 are off by several millimeters, which can produce an undesirable  
8 effect, particularly where article 14 is of a complicated shape, or article  
9 14 comprises a foldable container having a hinge which requires a high  
10 degree of accuracy in forming and severing thereof in order to accurately  
11 place the hinge.

12 Accordingly, an article registration device (not shown) can  
13 alternatively be added to punch plate 30 and die plate 32 in order to  
14 provide an enhanced ability to accurately register articles 14 between  
15 punch plate 30 and die plate 32 when severing such articles 14 from  
16 web 16. One suitable article registration device is disclosed in  
17 Applicant's pending U.S. Patent Application Serial No. 09/575,783,  
18 entitled "Apparatus and Method Registering Articles During a Web  
19 Processing Operation", naming the inventor as Jere F. Irwin, and herein  
20 incorporated by reference.

21 *Sub B* After severing articles 14 from web 16, the scrap web is delivered  
22 into a comminuting apparatus (not shown) that is provided directly  
23 beneath punch plate 30 and die plate 32. Several different comminuting

apparatus are suitable for grinding up the resulting scrap web are disclosed in U.S. Patents Nos. 4,687,144; 5,836,527; 5,860,607; and 5,893,523, each herein incorporated by reference. Scrap web 74 is accordingly forwarded into such a recycling, pulverizing machine where the scrap web is shredded and then later recycled to form a new web of thermoformable plastic material.

Details of one exemplary thermoforming machine suitable for forming articles 14 within web 16 are disclosed in U.S. Patent No. 5,773,540. U.S. Patent No. 5,773,540 is herein incorporated by reference.

Control system 18 of Figure 1 comprises a controller having control circuitry 68 such as processing circuitry and memory. According to one construction, processing circuitry is provided by a central processing unit (CPU). According to another construction, processing circuitry is provided by a microcontroller which cooperates to form the controller. It is understood that memory is operative to store software subroutines that are retrieved and implemented on the processing circuitry in order to impart motion control functionality by way of controller 18 to trim press 12 and conveyor 20.

As shown in Figure 1, control system 18 is operative to generate control signals that direct operation of servo drive motor 31 that drives crank arm assemblies 34-37 and thereby imparts reciprocation to movable platen 26. Servo drive motor 31 comprises a highly accurate computerized servo motor and servo drive which can be accurately driven



1 gross alignment structure which is received between adjacent rows of  
2 articles so as to grossly induce alignment of articles with web guide plate  
3 100 relative to article apertures 102.

4 *Ins. A1* Primary guide member 82 and secondary guide member 84 each  
5 include an attachment plate 92 having a quick release adjustment collar  
6 92 which includes a threaded, rotatable lock arm that enables clamping  
7 and unclamping of adjustment collar 92 along a central one of tire rods  
8 90. In this manner, primary guide member 82 and secondary guide  
9 member 84 can be quickly and easily laterally adjusted in position  
10 relative to web guide plate 100 so as to accommodate changes to  
11 different die configurations.

12 Primary guide member 82 further comprises a clamp bar 96 affixed  
13 with fasteners to attachment plate 94, and further affixed to support a  
14 guide strip 98 that is nested in proximate relation relative to a surface  
15 of guide plate 100. According to one construction, a gap exists between  
16 guide strip 98 and web guide plate 100 somewhere in the range of 1-3.5  
17 thicknesses of a web of material which is to be received and processed  
18 therebetween.

19 *Ins. A2* Secondary guide member 84 further comprises a clamp bar 96  
20 carried by attachment plate 94 and further supporting a guide strip 198.  
21 Guide strip 198 is constructed so as to provide a substantially greater  
22 amount of clearance between guide strip 198 and web guide 100 than is  
23 provided between guide strip 98 and web guide plate 100. Accordingly,

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1 guide strip 198 is spaced apart from plate 100 at least 3.5 thicknesses  
2 of a web which is to be received and processed therethrough.  
3 Preferably, web guide plate 100 is provided within a range of 3.5 to 10  
4 thicknesses (or more) of a web of material. In this manner, delivery of  
5 a web and articles there along is principally guided by guide strip 98,  
6 and little or not contact occurs between guide strip 198 and such web  
7 during a processing operation.

8 Additionally, as shown in Figure 2, article detector 80 comprises  
9 an optical emitter 104 carried by attachment plate 94 of primary guide  
10 member 82 and a detector 106 carried by attachment plate 94 of  
11 secondary guide member 84. A light beam 108 is generated from  
12 emitter 104 and received at detector 106. The presentment of an article  
13 between primary guide member 82 and secondary guide member 84  
14 causes interruption of light beam 108 which is detected at the control  
15 system 18 (of Fig. 1). Accordingly, the positioning of articles can be  
16 readily determined utilizing the control system and article detector 80  
17 pursuant to Applicant's invention.

18 As additionally illustrated in Figure 2, servo pick assembly 60  
19 comprises a pair of drive wheels 72 and follower wheels 70 along  
20 opposite edges of a web of material which is processed therebetween.  
21 Follower wheels 70 are retracted with each utilizing a knock lever  
22 mechanism 110 as treadle 10 is moved towards stationary platen 24 (of  
23 Fig. 1). Accordingly, drive wheels 72 and follower wheels 70 are



13 is spaced a significant distance away from plate 100, and principally serves to support detector 106. However, guide strip 198 also serves to grossly retain web 14 into position along plate 100 in the event that web 16 becomes suddenly significantly misaligned. Accordingly, under normal operating conditions, guide strip 198 serves as the only principal guide for retaining web 16 in close proximity against web guide plate 100. Accordingly, frictional forces therebetween are significantly reduced. Furthermore, emitter 104 and detector 106 further serve to detect the location and positioning of articles 16 as they are delivered via drive wheel 72 (and associated servo motor). All such control is choreographed utilizing controller 18 as well as a feedback signal from detector 106.

As shown in Figure 3, punch plate 30 includes a plurality of punches 22, each supported on axially guided springs. The springs facilitate interdigitation and lateral alignment with appropriately configured articles 14, and compress and coact with punch plate 30 during final severing against die plate 32 through the holes within plate 100.

As shown in Figure 3, follower wheels 70 are caused to open (or retract) away from drive wheel 72 via action of knock lever mechanisms 110 (see Fig. 2). Such retraction further facilitates lateral alignment of web 16 and articles 14 relative to punches 22 and dies within die plate 32.

Also illustrated in Figure 3, guide strip 98 is shown in close proximity with web guide plate, or web guide member, 100. In contrast, guide strip 198 is shown spaced relatively far apart from plate 100.

Figure 4 illustrates an enlarged partial view corresponding with line 3-3 of Figure 2, the relative positioning of guide strip 98 of primary guide member 82 (see Fig. 2) relative to web guide plate 100. Guide strip 98 is provided in relatively close proximity with plate 100 so as to ensure alignment and positioning of web 16 (and articles 14) relative to articles apertures 102 in plate 100.

In compliance with the statute, the invention has been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the invention is not limited to the specific features shown and described, since the means herein disclosed comprise preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.